

Possible Observation of a Second Kind of Light

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February 7, 2008

Abstract

According to classical electrodynamics, sunlight that is passed through an iron layer can be detected with the naked eye only if the thickness of the layer is less than 170nm. However, in an old experiment, August Kundt was able to see the sunlight with the naked eye even when it had passed an iron layer with thickness greater than 200nm. To explain this observation, we propose a second kind of light which was introduced in a different context by Abdus Salam. A tabletop experiment can verify this possibility.

August Kundt [1] passed sunlight through red glass, a polarizing Nicol, and platinized glass which was covered by an iron layer. The entire experimental setup was placed within a magnetic field. With the naked eye, Kundt measured the Faraday rotation of the polarization plane generated by the transmission of the sunlight through the iron layer. His result was a constant maximum rotation of the polarization plane per length of $418,000^\circ/\text{cm}$ or 1° per 23.9nm. He verified this result until thicknesses of up to 210nm and rotations of up to 9° .

In one case, on a very clear day, he observed the penetrating sunlight for rotations of up to 12° . Unfortunately, he has not given the thickness of this particular iron layer he used. But if his result of a constant maximum rotation per length can be applied, then the corresponding layer thickness was $\sim 290\text{nm}$.

Let us recapitulate some classical electrodynamics to determine the behavior of light within iron. The penetration depth of light in a conductor is

$$\delta = \frac{\lambda}{2\pi\gamma}, \quad (1)$$

where the wavelength in vacuum can be expressed by its frequency according to $\lambda = 1/\sqrt{\nu^2\epsilon_0\mu_0}$. The

extinction coefficient is

$$\gamma = \frac{n}{\sqrt{2}} \left[-1 + \left(1 + \left(\frac{\sigma}{2\pi\nu\epsilon_0\epsilon_r} \right)^2 \right)^{1/2} \right]^{1/2}, \quad (2)$$

where the refractive index is $n = \sqrt{\epsilon_r\mu_r}$. For metals we get the very good approximation

$$\delta \approx \left(\frac{1}{\pi\mu_0\mu_r\sigma\nu} \right)^{1/2}. \quad (3)$$

The specific resistance of iron is

$$1/\sigma = 8.7 \times 10^{-8}\Omega\text{m}, \quad (4)$$

its permeability is $\mu_r \geq 1$. For red light of $\lambda = 630\text{nm}$ and $\nu = 4.8 \times 10^{14}\text{Hz}$ we get the penetration depth

$$\delta = 6.9\text{nm}. \quad (5)$$

Only a small fraction of the sunlight can enter the iron layer. Three effects have to be considered. (i) The red glass allows the penetration of about $\varepsilon_1 \sim 50\%$ of the sunlight only. (ii) Only $\varepsilon_2 = 2/\pi \simeq 64\%$ of the sunlight can penetrate the polarization filter. (iii) Reflection losses at the surface of the iron layer have to be considered. The refractive index for electric photon light is given by

$$\bar{n}^2 = \frac{n^2}{2} \left(1 + \sqrt{1 + \left(\frac{\sigma}{2\pi\epsilon_0\epsilon_r\nu} \right)^2} \right). \quad (6)$$

For metals we get the very good approximation

$$\bar{n} \simeq \sqrt{\frac{\mu_r\sigma}{4\pi\epsilon_0\nu}}. \quad (7)$$

The fraction of the sunlight which is not reflected is

$$\varepsilon_3 = \frac{2}{1 + \bar{n}} = \frac{2}{1 + \sqrt{\mu_r\sigma/(4\pi\epsilon_0\nu)}} \quad (8)$$

and therefore $\varepsilon_3 \simeq 0.13$ for the system considered. Taken together, the three effects allow only $\varepsilon_1\varepsilon_2\varepsilon_3 \sim 4\%$ of the sunlight to enter the iron layer.

The detection limit of the naked eye is 10^{-13} times the brightness of sunlight provided the light source is pointlike. For an extended source the detection limit depends on the integral and the surface brightness. The detection limit for a source as extended as the Sun (0.5° diameter) is $l_d \sim 10^{-12}$ times the brightness of sunlight. If sunlight is passed through an iron layer (or foil, respectively), then it is detectable with the naked eye only if it has passed not more than

$$(\ln(1/l_d) + \ln(\varepsilon_1 \varepsilon_2 \varepsilon_3))\delta \sim 170\text{nm}. \quad (9)$$

Reflection losses by haze in the atmosphere further reduce this value.

Kundt's observation can hardly be explained with classical electrodynamics. Air bubbles within the metal layers cannot explain Kundt's observation, because air does not generate such a large rotation. Impurities, such as glass, which do generate an additional rotation, cannot completely be ruled out as the explanation. However, impurities are not a likely explanation, because Kundt was able to reproduce his observation by using several layers which he examined at various places.

Quantum effects cannot explain the observation, because they decrease the penetration depth, whereas an increment would be required.

The observation may become understandable if Kundt has observed a second kind of electromagnetic radiation, the magnetic photon rays. They are predicted by a quantum field theoretical model of the electromagnetic interaction which includes Dirac magnetic monopoles [2]. This model can be constructed in a manifestly covariant and symmetrical way if the two potential concept [3, 4] is used. One potential corresponds to the electric Einstein photon [5], the other one to the magnetic Salam photon [6, 7, 8, 9, 10, 11]. A few years ago, I predicted the interaction cross-section of the magnetic photon to be $f = 1.5 \times 10^{-6}$ times that of an electric photon of the same energy [10]. Each process which produces electric photons is expected to create also magnetic photons which are $1/f = 7 \times 10^5$ times harder to create, to shield, and to absorb than electric photons. Hence, the penetration depth of magnetic photon light of $\lambda = 630\text{nm}$ in iron is $\delta/f \approx 5\text{mm}$.

To learn whether Kundt has indeed observed magnetic photon rays, his experiment has to be repeated.

The easiest test to verify/falsify the magnetic photon is to illuminate a metal foil of thickness $1, \dots, 100\mu\text{m}$ by a laser beam (or any other bright light source) and to place a detector (charge coupled

device or photomultiplier tube) behind the foil. If a single foil is used, then the expected reflection losses are less than 30%. If a laser beam of the visible light is used, then the absorption losses are less than 15%. My model [10] has to be considered as falsified if the detected intensity is less than 1.0×10^{-12} times the intensity that would be detected if the metal foil were removed and the laser beam would directly illuminate the detector.

References

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